

Storing and Sharing Environmental Data and Information

Jim Quinn (UCD)
Session Chair

Background

An enormous quantity of environmental data is produced each year from monitoring and research around the Estuary and its watersheds, adding to a remarkable long-term record of many aspects of environmental conditions. Much of it could potentially help scientists and managers remain informed about the state of natural resources, particularly with respect to restoration projects. Unfortunately, many of these environmental data still exist in diverse, incompatible formats, and are housed in different databases that are often difficult to find or access.



This session highlighted efforts to integrate these data. Speakers represented half a dozen ambitious projects that aim to assemble and catalog these data and make them accessible through web portals.

Effective data sharing requires storage and integration of data from multiple sources in compatible formats. It also requires incorporation of metadata ("information about data"), such as by whom, when, where, and how data were collected, the meanings of variable names

and codes, measurement units, and instructions for accessing the data electronically. Core issues include data format standards, shared vocabularies, documentation, mechanisms for information exchange, and incentives for participation.

Several initiatives described below are making progress. Major goals of these efforts include supporting CALFED activities by providing ease of use, integration, standardized metadata, and analytical tools for

environmental data. These efforts also contribute to building on our remarkable legacy of long-term monitoring, which has proven its worth through insights into the ecological workings of the Estuary. Such efforts may ultimately play key roles in evaluation of restoration efforts identification of the factors associated with project success. All are works in progress, but promise to make it easier for scientists, policymakers, and the interested public to evaluate the changes and effects of environmental protection in the Estuary and its watersheds.

MANAGEMENT IMPLICATIONS

- Accurate post-project appraisal depends on the availability of pre-project data (success criteria, baseline surveys, and design rationale) and post-project data (monitoring surveys, supplementary historical data, and secondary analysis). Managers are encouraged to submit all relevant project information to NRRSS databases. (Kondolf)
- Metadata integrated into the Interagency Ecological Program (IEP) Environmental Monitoring Program (EMP) databases can be used to summarize data and allow comparison of results along a variety of user-selected parameters. (Vaysseries)
- Online web libraries and portals improve access to important watershed information and enhance communication among groups working within the watershed (Wolf)
- Managers in the Central Valley can access and share information in the Central Valley Watersheds Library (www.watershedportals.org/cv) (Wolf).
- New incentives could improve metadata submittal to web libraries. Funders could require all funded projects to provide metadata that includes the standard Dublin Core information, and local and state laws could require users of public funds to add metadata when the information enters the public domain. If web libraries become well populated with resources, they will draw content providers to list in them. In future, the reputations of individuals and organizations may be enhanced by the quality of their adopted sections of the universal web library. There are multiple catalogs serving the Bay-Delta region that can provide portals to public information for different user communities (Wolf).
- Participation in the CEDEN system allows managers to share data efficiently while maintaining local control of their own data. CEDEN staff provides technical assistance to data providers. Enterprise applications can be modified by multiple users in the CEDEN system so that data can be queried and used with GIS and modeling software (Jacobs, Connor).

REPOSITORIES OF SCIENTIFIC INFORMATION

- The National Riverine Restoration Science Synthesis (NRSS -- <http://www.nrrss.umd.edu/>) has collected over 45,000 project files into a database with 4,000 project files from California. The database contains information on \$2 billion dollars worth of California projects, from tiny ones to a \$150 million dollar effort. Most money in California was spent on riparian management, water quality, and bank stabilization projects. Only 22% of projects reported monitoring (Kondolf).
- Graduate students in hydrology and restoration courses will be assisting with post-project analyses, with results and research papers posted online through the California Water Symposium (<http://www.lib.berkeley.edu/WRCA/>) (Kondolf).
- Integrating metadata within a database can ensure consistency, ease of querying, and data usefulness.

Metadata can help users to determine things like whether patterns are due to sampling or analysis techniques (Vayssieres).

- Web libraries can be used to access data in an accessible and easily searchable format. In order to be sustainable and successful, web libraries need standardized metadata and controlled vocabulary lists. Experience suggests public libraries should use open source or public domain software, decentralized infrastructure with more centralized data harvesting, caching, cataloging, and searching, and more incentives for content providers. Dublin Core search fields provide basic information (e.g., title, data, keywords) and as well as metadata (e.g., origin, copyright, format), and are becoming increasingly adopted as a document cataloging standard by the digital library and open-source communities (Wolf).
- CalClim (www.calclim.dri.edu) monitors climate variability and change in California, provides a reliable source

for summarized climate data previously available only through non-integrated sources, and distributes information via California Climate Data Archive (CCDA) and the online newsletter California Climate Watch. Summarized climate data includes daily and monthly summaries, time series graphs, wind rose graphs and tables, frequency distributions, inventories, metadata and recent anomaly maps (Edwards).

- The California Environmental Data Exchange Network (CEDEN -- <http://baydelta.ca.gov/Php/ceden.php4>) will build on the long-standing Bay-Delta and Tributaries (BDAT -- <http://baydelta.ca.gov/>) information services to promote collaboration among groups collecting, storing and sharing water quality and monitoring data within the Estuary. An ambitious new resource within the CEDEN framework is the Surface Water Ambient Monitoring Program (SWAMP -- <http://www.swrcb.ca.gov/swamp/>) (Jacobs, Connor).



Integrating Science and Management

Zachary Hymanson (CBDA)
Session Chair

Background

The overarching question of how to effectively integrate scientific advances into management is central to a complex, collaborative process like CALFED. Much of the information presented was more social science than natural science: case studies of attempts to make science useful. In such attempts, organizational and institutional realities are often more relevant than scientific minutiae. Both scientists and managers can learn from the successes presented here.

One common theme was the use of adaptive management. While this term means many things to different people, here it takes the form of iterative management efforts, where each step takes science into account. This use of the scientific method allows hypothesis-testing to inform decision-making, providing a basis for management actions that can change as scientific knowledge improves.

Language is one source of disconnect between scientists and managers. Scientists often speak in terms of probabilities and narrowing uncertainties, as data often have limited ability to produce definitive “yes or no” answers. Policymakers and man-

agers, on the other hand, often need to make “yes or no” decisions. How much gets lost in translation between the two depends in part on innovative communication ideas, and in part on continued open dialogue between scientists and managers.



MANAGEMENT IMPLICATIONS

South Bay Salt Pond Restoration Project (Trulio)

Historically this 15,000+ acre area was a tidal marsh. Habitat modifications and ongoing management have resulted in salt ponds that now provide habitat for migratory shore birds and waterfowl. In part because of this history, restoration of the salt ponds poses a variety of complex ecological challenges and choices among human-derived values. To implement a scientifically sound restoration project, an organizational structure incorporates input from scientists, stakeholders, and decision makers, through an iterative process of generating and synthesizing scientific information for decision-makers.

A science structure draws on current scientific data and analyses to provide the information needed to

address key questions and integrate the data into decision-making. Such translation is critical in spanning the gap between science and policy. Elements central to integrating science and decision-making include:

- Collaboration and peer-review, including consultant products
- A science structure that provides up-to-date scientific information to project managers and stakeholders
- Scientific basis for project objectives

San Francisco Bay Mercury TMDL (Mumley)

A Total Daily Maximum Load (TMDL) has been established for mercury in San Francisco Bay. Its success may rest on adaptive implementation. Drawing on technical work including documenting sources and developing numerical targets, the implementation strategy

incorporates an adaptive approach towards controlling loads.

Monitoring and scientific study are critical to addressing uncertainties and progress towards goals at every stage. A commitment to revisit decisions on TMDL elements every five to ten years is central to the strategy. This tangible reflection of the decision to incorporate new scientific information acknowledges the possibility that initial targets may not be appropriate after years of scientific scrutiny.

Probabilistic Approach for Mitigating Mercury Sources (Wood)

There is always uncertainty in restoration decisions. Current processes typically use deterministic models to predict responses, often ignoring or downplaying the uncertainties involved. Risk is often considered in an ad-hoc way outside formal analytical frameworks.



Suisun Marsh

Many uncertainties exist concerning the physical, chemical, and biological processes of mercury in the Cache Creek watershed. A novel approach to integrating science and management uses a probabilistic model to explicitly incorporate scientific uncertainty, cost information, and value judgments. By dealing with uncertainties rigorously and explicitly, the method may allow decision makers to understand and respond to the sources and amounts of uncertainty. The decision tool also presents results in a usable (visual) form, in this case maps. The method may help decision-makers understand how uncertainty impacts decisions. It may also provide direction for future data collection, and increase transparency.

Ecological Scorecard San Francisco Bay Index (Pawley)

This comprehensive assessment of the Estuary's condition was first developed in October

2003, and recently applied to finer scales in Suisun Bay. Suisun Bay is responsive to many of the Estuary's worst ecological stressors: invasive invertebrates, contaminants, reduced freshwater inflow, reduced sediments. This analysis revealed a significant downward trend in the ecological health of Suisun Bay in comparison to the Estuary as a whole. The Scorecard permits the examination of ecosystem health at multiple scales. Regional and finer scale analysis could be used to develop performance measures addressing CALFED goals.

Benefits of the Ecological Scorecard include:

- A regional, landscape-level assessment of ecosystem condition,
- A synthetic view across agency jurisdictions that addresses CALFED goals,
- A simple structure facilitating communication with the public, managers and decision makers,

- Indices based on conceptual models that aggregate for public level consumption and disaggregate for performance measurement.

Indicators of Ecosystem Health and Restoration Effectiveness (Swenson)

Easily quantifiable measures of restoration actions (such as dollars spent or acres restored), fail to represent the actual success of conservation efforts. Through a conceptual model-based framework, The Nature Conservancy identifies target species and communities and assesses their ecological health. The framework also identifies and prioritizes stresses to systems, and develops actions to abate threats to ecosystem health. The framework is currently being tested on the Sacramento and Cosumnes rivers. Overall, the framework is robust and useful, although improvements could include increased scientific rigor and more explicit objectives.

Data and Advocacy: The Role for Environmental Justice

Paula A. Daniels (CBDA)
Session Chair

Background

Environmental Justice (EJ) is a central CALFED commitment, as defined in the Record of Decision:

The CALFED Program and its participating agencies are committed to seeking fair treatment of people of all races, cultures, and incomes, such that no segment of the population bears a disproportionately high or adverse health, environmental, social or economic impact resulting from CALFED's programs, policies, or actions.

By its nature, EJ action involves affected communities, whether through grassroots organization

and mobilization, or in the form of participatory scientific research. Science can be a powerful tool to demonstrate geographic and sociological disparities in environmental impacts of development, and help suggest solutions. However, the melding of science and community interests is not automatic. As in any complex system, problems can arise from miscommunication and lack of integration. Scientific research and science experts do have the ability to support EJ, yet it is important for scientists to understand their role, particularly in the context of a perceived schism between science and activists. One key lesson is that learning and support need to go both ways – scientists can more effectively target their research if they seek out and respond to local knowledge of affected communities.



Striped Bass

For topical background, research presented here focused, among many key contaminants of EJ concern, on mercury and methylmercury. Like other contaminants, these can bioaccumulate in sportfish. This can lead to human health problems in populations that consume them. More background on this topic can be found in the mercury session of this volume on page 56. Another consistent message is that monitoring is critical for managing EJ problems, and increased, targeted monitoring needs to be supported.

MANAGEMENT IMPLICATIONS

- Scientific data and experts can support environmental justice advocacy, yet it is important that scientists understand that their roles can have varying effects (Cole).
- Community based participatory research can be integrated into ecosystem research to foster co-learning, ensure community-driven projects, incorporate fair research strategies, and increase the relevance of research questions addressed in studies (Running Grass).
- Efforts to control human health impacts of methylmercury in native fisheries can potentially cause socio-cultural damage to human communities (Wiener).
- Integrating monitoring, health risk assessment, and risk communication into management could help stem health risks from methylmercury (Wiener).
- Recommendations for conducting effective methylmercury outreach activities include: collaborate with local groups, develop appropriate educational materials, emphasize visual images and mass media outlets, and provide training (Ujihara).
- The Regional Monitoring Program, the Sacramento River Watershed Program and the CDBA Fish Mercury Project are providing some data about pollutants found in the Estuary and its watersheds. However, a long-term monitoring program that extends spatial coverage, evaluates multiple species and contaminants is needed to continue to develop a better understanding of the health risks associated with Bay-Delta fish consumption (Davis).
- Increased monitoring of fish tissue at heavily fished sites, and multi-lingual surveys of angling activity could help fill gaps in scientific and sociological information on fish consumption (Shilling).
- To provide equal protection and benefits to all fish consumers statewide, more monitoring and assessment is needed. More quality data on fish, water bodies where people fish, and on organic chemicals are needed (Brodberg).

SCIENTIFIC INFORMATION

- Scientists play several roles in Environmental Justice efforts, sometimes positive, sometimes not. They *document* new information, which can *catalyze* change by revealing patterns. By presenting knowledge gained from scientific research, scientists can act to *legitimize* or *delegitimize* community knowledge of environmental change, or *justify* an agency's position. As a *savior*, a scientist may attempt to solve a community problem, but sometimes instill false hope (Cole).
- Community-based participatory research involves the collaboration of community members and scientists. Drawing on community members' expertise about their own environment can strengthen collective understanding of changes and impacts (Running Grass).
- Subsistence fishing by native tribes in Canada provides a high-quality food source, but also promotes self-reliance, meaningful work, cultural identity, and spiritual connectedness. When abandonment of subsistence fishing was promoted to prevent the adverse effects of methylmercury poisoning, native communities in Canada suffered adverse effects both physically and culturally. Research results showed a shift to unhealthy diets, increasing health problems, increased unemployment, less active social lifestyles, increased drug and alcohol abuse, and increased domestic violence (Wiener).
- Methylmercury and organic pollutants such as PCBs, legacy pesticides, dioxins, and PBDEs are associated with fatty tissue in fish. Humans can reduce exposure to these pollutants by removing the

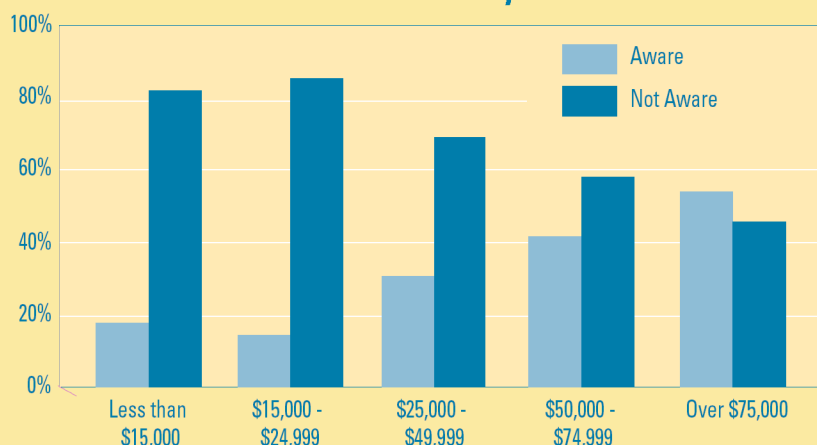
skin from fish during food preparation (Davis).

- There is incomplete geographical overlap between knowledge about fishing practices and fish mercury levels (Shilling).
- The Office of Environmental Health Hazard Assessment (OEHA) has developed a consistent statewide protocol for fish consumption advisories. A safe eating level is determined based on risk assessment of contaminants. A safe meal level (how many fish per month) is determined, and then concentra-

tions in fish are provided that correspond to those safe eating levels (Brodberg).

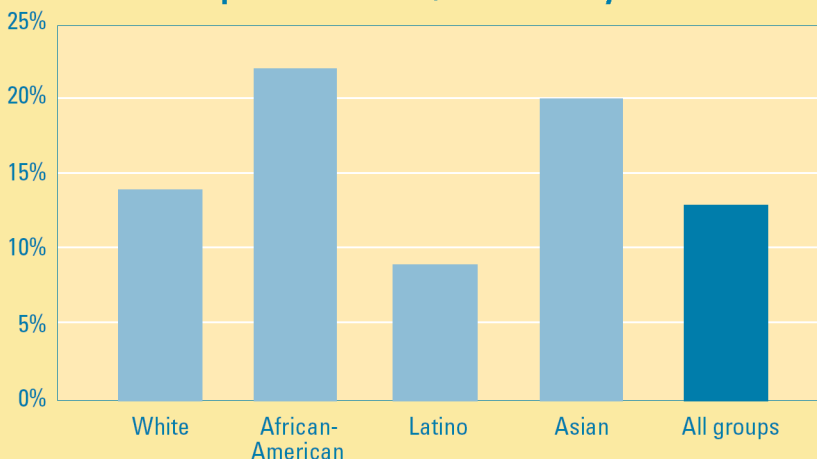
- Fish consumption puts many ethnic groups at risk of exposure to contaminants, but many are unaware of existing advisories. Outreach and educational activities around the Estuary include educational materials emphasizing images, fish consumption surveys, and local stakeholder involvement in fish monitoring and educational activities (Ujihara).

Awareness of Health Advisories by Income



Awareness of health advisories by women of childbearing age is lowest among low-income people surveyed (Figure – A. Ujihara and co-authors).

Fish Consumption Above FDA/EPA Advisory



Preliminary results of a statewide phone survey of women on fish consumption. These data may not reflect specific ethnic populations or geographic areas of greatest concern to CALFED (figure courtesy A. Ujihara and co-authors).

Water Supply

Jerry Johns (DWR)
Session Chair

Background

Until recently in California, water supply was historically the domain of civil engineers, who responded to the State's needs for supply and reliability with large construction projects. Today, the feasibility of new infrastructure projects is limited, but demands on water supply continue to grow. In addition to demand changes from increased population, climate change may alter water supplies in coming years, leading to great uncertainty in future planning (see Climate, page 79). All of this change will occur against the backdrop of the need to consider impacts on ecosystems and species of concern. Bringing science to bear on an engineered system can help incrementally increase the efficiency of an existing system to meet the uncertainties from both ends. Approaches presented included water use efficiency, new water purification technology, economic optimization, and climate science. Ultimately, all of these approaches will help develop a diversified water portfolio that will serve California's growing needs.

MANAGEMENT IMPLICATIONS

- A model of Best Management Practices for urban water conservation can be used at the agency, regional, and state level for water management planning (Mitchell).
- Desalination of agricultural drainage water is a possible new water supply option that is both economically and scientifically feasible. It has the potential to solve environmental problems, sustain agriculture, and provide 300,000 acre feet per year of "new water." However, the technology is expensive, and its economic viability depends on urban areas' willingness to pay prices as high as seawater desalination or second-tier water recycling prices (Enzweiler).
- Adaptation and impact studies of climate change need to include a broader view of hydrology and water management options (such as groundwater), as well as other long-term changes (such as population) (Lund).
- Distant climatic events can be used for possible early water supply forecasting, or asset planning for EWA (Brekke).
- Innovative programs like the Environmental Water Account may protect key fish species of concern while protecting water supply reliability (Johns).



SCIENTIFIC INFORMATION

- Best Management Practices for urban water agencies have saved significant amounts of water throughout California's urban water sectors. Some of the greatest savings came from retrofitting to low-flow toilets (Mitchell).
- Desalination of agricultural drainage water produces selenium as a byproduct, as well as calcium sulfate that can clog membranes. New technology called double pass preferential precipitation reverse osmosis may solve this problem, producing high quality irrigation water that is low in boron (Enzweiler).
- 'Teleconnections' are relationships between climatic events in widely separated parts of the globe. New work identifies teleconnections that correlate with water supply variables in California. Such responses show promise as a new tool for water supply forecasting in Central Valley basins (Brekke).

Climate

Michael Dettinger (USGS & Scripps),
Dan Cayan (Scripps & USGS) and
Kelly Redmond (DRI)
Session Chairs

Background

Assuming that greenhouse gas concentrations in the atmosphere will continue to increase as more and more fossil fuels are burned, current climate models yield a range of climate-change scenarios for California. Detectable changes have already taken place in temperature and the timing of streamflow. The climate models suggest changes will get progressively larger, and that substantial changes may arrive within twenty years (Dettinger).

By the middle of the 21st century, even the “coolest” of the models project much earlier snowmelts and major reductions in snowpacks and water resources of the Sierra Nevada. The upshot will be a very different seasonal hydrological cycle for California streamflow and water supplies. This will include more severe winter floods, and much drier springs and summers. Sea level rise will also impact coastal areas, with the greatest coastal impacts coming from high tides in conjunction with storm events.

In the face of these projections, and their attendant uncertainty, California is engaged in making major long-term decisions balancing resource management and ecosystems restoration. Determining how to incorporate this uncertain climate-change information into management decisions is a daunting challenge.

One ongoing effort to incorporate climate change scenarios into California water resources planning and management is the Climate Change

Work Team, a collaboration between the U.S. Bureau of Reclamation and the California Department of Water Resources. Major areas of analysis include impacts of climate change on water temperature and quality with ecological ramifications, implications for storage capacity, and impacts on levee stability (Brekke).

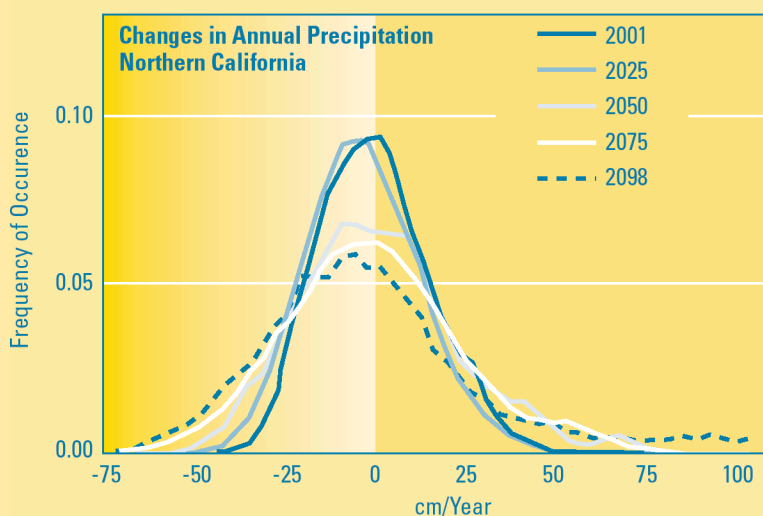
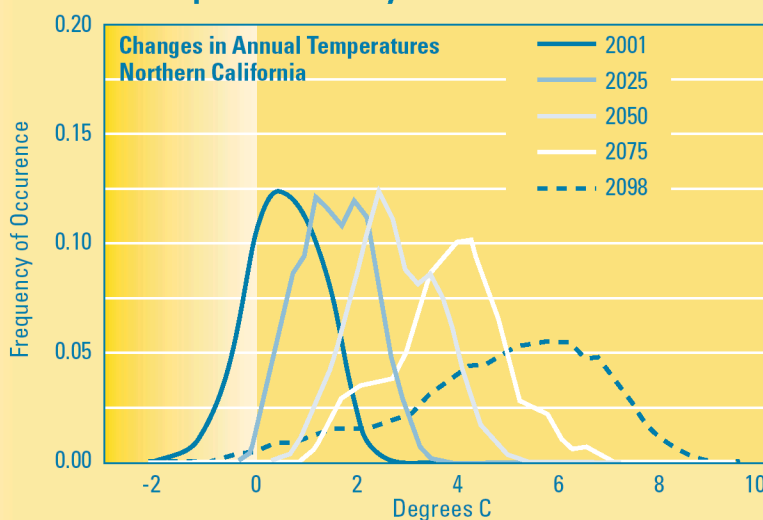
Overall, climate change has the potential to impact a broad range of CALFED programs and stakeholders across the board. Preparing for these changes will require close attention as new knowledge emerges from continued research.

SCIENTIFIC INFORMATION

- Studies of Sierra lake sediments and tree-ring records describe

hydrological variations over the past 15,000 years. From 4000 to 8000 years ago the Sierra was drier than today. Beginning 4000 years ago there were multi-decadal to centen-

Resampled Probability Distributions



There appears to be less consensus about projections of future changes in precipitation than temperature for Northern California. Ensembles of historical and future (a) temperature and (b) precipitation changes from seven coupled ocean-atmosphere general-circulation models of the global climate forced by various greenhouse-gas-plus-sulfate-aerosols emissions scenarios (figures courtesy M. Dettinger)

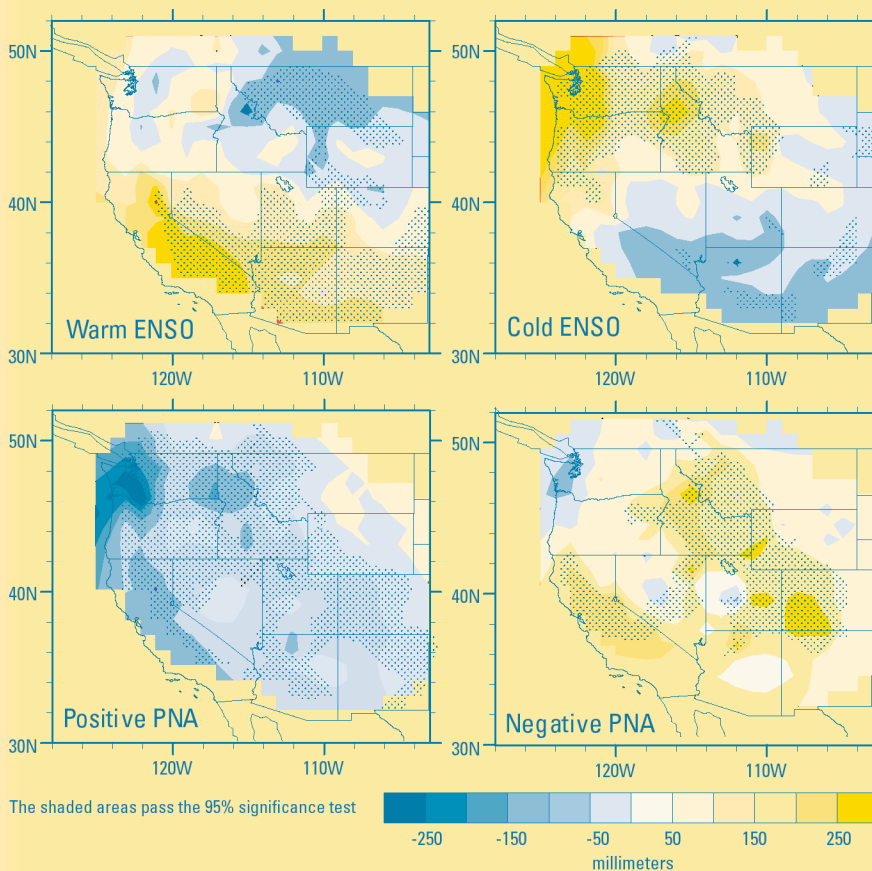
nial periods of moister conditions. Evidence from the past 1200 years indicates that very long (centennial scale) and more severe drought than witnessed in the 20th Century are likely (MacDonald).

- Of four tree species studied, *Pinus balfouriana* accounted for the most variability in paleohydrologic records in California, but still only captured roughly 50% of the total variability. Thus, multi-species records are crucial for accurate reconstructions of past climatic and hydrologic fluctuations. New work revealed natural patterns of low-frequency climate fluctuation in the past millennium that were more extreme than those witnessed during the past century (Meko).
- Spring and early summer snowmelt surges are an important part of the overall variability of runoff in western mountains. These surges have been arriving earlier in the spring due to a warming climate. Sierra snowmelt often leads the Rockies by one to five days in a broad Western pattern. Climate warming would likely shift higher elevation catchments toward the behavior of lower elevation catchments (Cayan).
- El Niño-Southern Oscillation (ENSO) and the Pacific-North America (PNA) circulation patterns are each correlated with anomalous snowpacks. Warm phase ENSO events (El Niños) produce increased snowpack, due to increased precipitation (and vice versa for cold phase

ENSOs or La Niñas). The “deep Aleutian low” phase of PNA also leads to above normal snowpack (Jin).

- Warmer temperatures, which in turn induce earlier snowmelt, are associated with the El Niño-like phase of the Pacific Decadal Oscillation (PDO). The PDO phase reversed in 1998 (from its El Niño-like phase to its La Niña-like phase), but the warming trend of the past 50 years continued, as did the earlier snowmelt. This suggests part of the warming trend may be attributed to global climate change (Stewart).
- Analysis of CIMIS data reveals that the evaporation demand, represented by daily potential evapotranspiration (ET_o), is well correlated with positive net radiation anomalies, negative relative humidity anomalies, and negative cloud cover anomalies; weaker correlations occur with temperature. ET_o daily values exhibit greater variability in the spring, with daily anomalies correlated with spring circulation patterns. An increase in temperature of 3 degrees Celsius, as some climate-change scenarios predict, could increase annual ET_o totals by approximately 6%, if not compensated by changes in net radiation (Hidalgo).
- In the historical record, a new Western Drought Index reveals an observed regional trend in increased temperatures, but no trend in the number of dry years. A corresponding California Drought Index shows wet periods getting wetter, as does the Western Index. The California Index tends to parallel the Western Index. Overall, both indices reveal trends towards increasing temperatures (Gershunov).

Snowpack Anomalies in the Western United States



Snowpack Anomalies in the western United States: El Niño-Southern Oscillation (ENSO) and the Pacific-North America (PNA) circulation patterns are each correlated with anomalous snowpacks (figure courtesy J. Jin).

- Over the past 50 years, there has been a trend towards increased frequency and duration of storminess along the California coast. Non-tidal mean sea level, storm frequency, and intensity all have trended upwards, and the highest five-year mean since 1858 occurred during the 1990s (Bromirski).
- Statistical averaging of multiple models showed a relatively good fit against the historical record for the American River. Such “consensus forecasts” may provide a more robust prediction than a single-model approach (Duan).
- Statistical resampling of projections from six climate models under three greenhouse-gas emission scenarios each suggests: 1) There are dual sources of uncertainties – uncertain future emissions and differences among climate models. Both are of the same magnitude and neither can responsibly be ignored. 2) The probability distributions obtained from re-sampling indicated that temperature-change scenarios vary more than precipitation change. 3) It is statistically unlikely that California will have an extremely wet future. 4) There is clear correlation in models between temperature and precipitation: warmer scenarios are typically also drier, and vice versa (Dettinger).
- The impacts of specific climate-change projections on water quality were assessed in the context of agricultural and municipal standards for chlorides and electro-conductivity. At the Contra Costa intakes, reduced violations in winter were projected in response to increased rainfall, and increased violations in dryer rainfall (Anderson).

MANAGEMENT IMPLICATIONS

- CALFED management strategies based upon historical instrumental records of hydrological variability will underestimate the potential magnitude and duration of future droughts (MacDonald).
- A shift in the timing of spring snowmelt may require new management plans for California watersheds. Water managers would clearly prefer a gentle, continuous spring melt. Evidence suggests there will be more (and possibly earlier) surges in spring snowmelt and streamflow, resulting also in shorter runoff periods (Cayan).
- A historical trend towards earlier snowmelt seems to be driven, in part, by global climate change and, if continued, could impact water supplies for California. The trend is projected to continue, with snowmelt arriving 20-30 days earlier by the end of the century in the Pacific Northwest, Sierra Nevada, and Rocky Mountains (Stewart).
- Snowpack provides approximately 75% of runoff to California's streams, so accumulation of snowpack is an important element of water management. Water managers may find prediction of snowpack based on ENSO and PNA useful in their planning (Jin).
- Projected increases in potential evapotranspiration (ET_o) may in turn result in increased water demand in the agricultural sector. With a three degree Celsius temperature rise, agricultural water demand would increase by approximately 6% (Hidalgo).
- A historical trend towards increasing storminess has been observed. If it continues, it could change requirements for coastal planning and design criteria (Bromirski). Arguably, resulting higher sea levels may also influence Bay and even Delta wetlands, marshes, and levees.
- A denser and better instrumented network of high-elevation monitoring stations will help elucidate the poorly-understood linkage between high-elevation and low-elevation climate variation. Such a network could expand on existing stations (Redmond).
- Climate models are still very uncertain, but some elements (e.g. temperature) are more clearly projected than others (e.g. precipitation). New techniques may allow probability distributions to be used in decision-making, as opposed to a focus on extremes in modeling projections (Dettinger).
- Preliminary results of an effort to link climate models and CALSIM II show that typical climate scenarios result in some decrease in reservoir storage at the end of September, within 20-30 years. The scenarios also show decreases in CVP and SWP water deliveries (Ejeta).
- A major consideration in the face of climate change is impacts on water quality. Preliminary findings suggest patterns of violations in water quality standards at Contra Costa water intakes could change with projected climate changes. However, existing operations rules may be sufficient to continue meeting water quality standards under some climate scenarios (Anderson).